

NHDOT SPR2 PROGRAM

RESEARCH PROGRESS REPORT

Project # SPR 26962V		Report Period Year 2019 <input type="checkbox"/> Q1 (Jan-Mar) <input type="checkbox"/> Q2 (Apr-Jun) <input checked="" type="checkbox"/> Q3 (Jul-Sep) <input type="checkbox"/> Q4 (Oct-Dec)	
Project Title: The Development of a Predictive Tool for Bridge Condition with Respect to Recommended Investment Strategy			
Project Investigator: Erin Bell Phone: 603-862-3850		E-mail: erin.bell@unh.edu	
Project Start Date: 07/31/2019	Project End Date: 12/31/2021	Project schedule status: <input type="checkbox"/> On schedule <input type="checkbox"/> Ahead of schedule <input checked="" type="checkbox"/> Behind schedule	

Brief Project Description:

Reliable data-driven forecasting models allow for public agencies to plan for future needs and resource allocation. Conditions of bridge assets are managed through maintenance, preservation, rehabilitation and reconstruction. The New Hampshire Department of Transportation documents the appropriate timing of these treatments in Recommended Investment Strategies (RIS). According to NHDOT best practice and expert judgement adhering to a bridge's RIS extends useful service life. Quantification of the service life extension as well as tracking how well bridge investments have adhered to RIS remains a challenge. Bridge work is often documented in disparate formats through multiple bureaus and systems.

Element-level condition assessment data is collected and tracked in a standardized format for each bridge asset in a transportation network. Maintenance and repair records, however, are not and must be tabulated before correlation with other data. Correlating this tabulated data with conditions will support the development of deterioration models that function according to treatment actions, environmental condition and traffic usage. Condition forecasting using such deterioration models will provide insight into the long-term ramifications of investment strategies that leverage varying amount of maintenance, preservation, and rehabilitation

Objective of this project:

1. Data Collection and storage tool for bridge investment records
2. Recommended Investment Strategy adherence measure and effectiveness measure
3. Recommendation of appropriate deterioration models of NH bridge inventory
4. Proof-of-concepts deterioration forecast using a sample data set

Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):

The project team continued working remotely, due to COVID-19, and made progress on project tasks described below.

Literature reviews

Drafts of the following literature reviews are completed and will be shared with the DOT for review this quarter (Q4): 1) best practices for bridge subset selection and bridge condition forecasting using maintenance data 2) RIS factor weighting techniques and 3) expert judgement solicitation for supplementing the factor weight literature review.

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Expert solicitation

Based on the literature review, feedback from the April TAG meeting, and COVID-19 restrictions, we are planning a remote expert solicitation for RIS activity weighting. To obtain consensus among experts, we will use a Delphi study that asks respondents to take a survey (or answer questions during a group meeting), providing the group answers back to the respondents, and having them retake the same survey. This process repeats until variability between survey rounds is reduced below a preset threshold, often only two rounds. We will use pairwise comparison and the Analytical Hierarchy Process to develop the survey questions and calculate the activity weights. The questions will ask respondents to rate how much more/less important one activity is in comparison to another activity to the long-term performance of the bridge.

During the August TAG meeting, the project sponsor described a preference for in-person or a Zoom group meeting, as opposed to an entirely survey-based method. The UNH team stated that an initial individual survey can help reduce potential biases common during group meetings (for example groupthink and social desirability). To include the benefits of both approaches, the expert solicitation plan now includes an initial survey to collect individual, anonymous data, and a group Zoom meeting to review the survey results and update individual rankings. Given the updates to this expert solicitation plan, the UNH team will be submitting the IRB application at the beginning of Q4. The review is expected to be quick and the survey will most likely be sent in late October or early November.

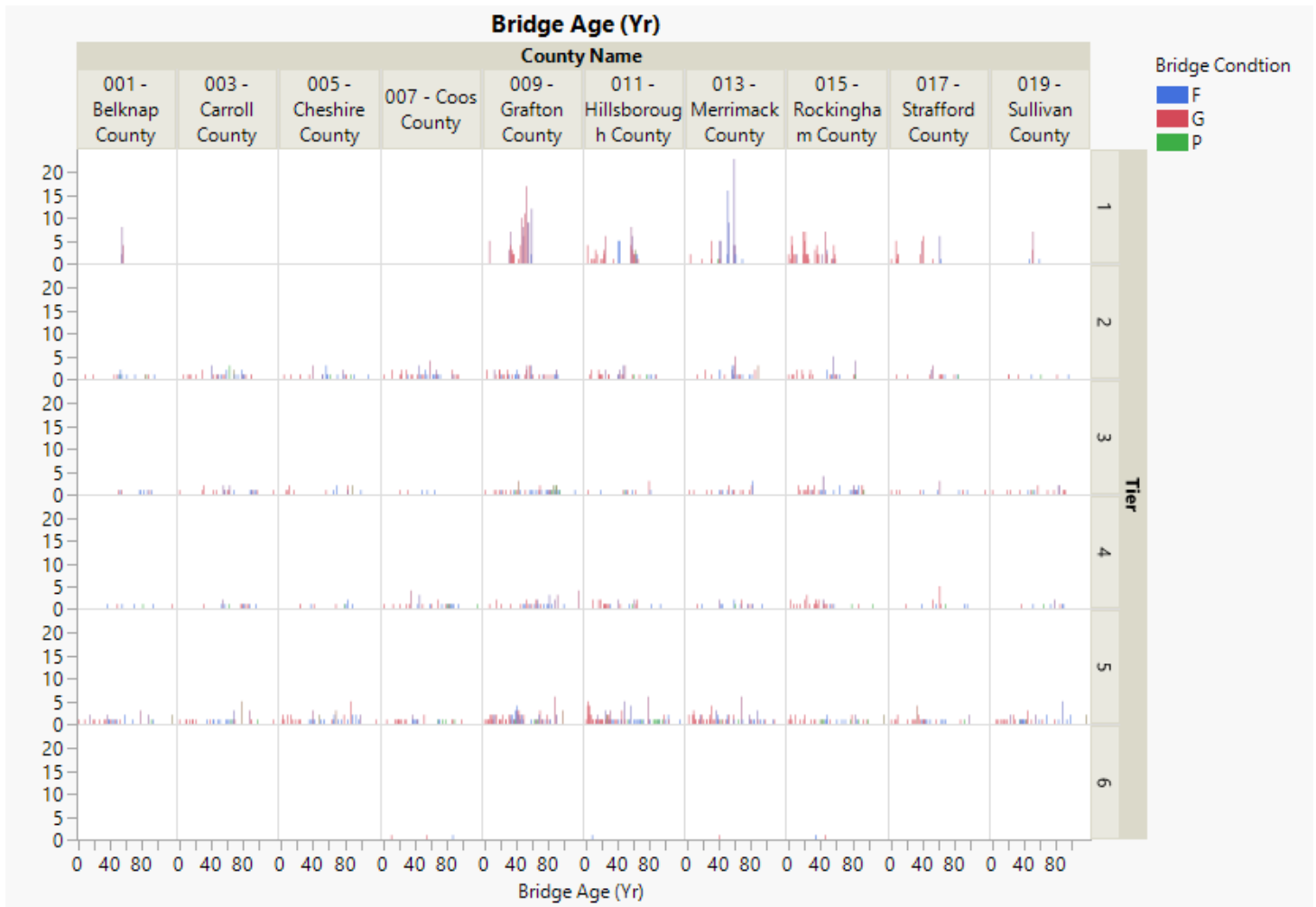
Additionally, we discussed the list of participants for the expert solicitation during the August TAG meeting. Initially, the participants were planned to include only a small group of DOT experts. However, we discussed the potential to include additional respondents, including other state DOT bridge managers (primarily Maine and Vermont), municipal public works (for example Martha Drukker in Concord), and additional DOT employees outside of the group originally involved in RIS creation. We would like to finalize this list in October while the IRB application is in review.

Data analysis

The bridge characteristic and condition data has been combined with Activity Log activities, to summarize the network data and aid in sample set selection. Based on discussions from the April 2020 TAG meeting and new analysis, the categories for selecting the sample data set have changed since the last progress report. The data will be separated into categories by NHDOT Tier, Location (i.e. County), and Condition Rating. A summary of those categories using the current data is provided below.

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We are still in the process of selecting a representative number of bridges from each category for the sample set. The exact bridge IDs need to be selected based on which bridges have available activity data. We currently have only the Activity Log data to complete the selection. During the August TAG meeting, the DOT discussed additional data sources that UNH does not currently have (for example Time in Condition State and inspection data). Additionally, the TAG mentioned a desire to either focus exclusively on, or include a specific subset of, National Highway System (NHS) bridges. The UNH team would like to have a small group meeting to create an inventory of available data sources relevant for this project before making a final bridge subset selection.

RIS Tool

The RIS tool was discussed at the August TAG meeting, however most of the discussion focused on data. Some of the questions presented in the Q2 progress report remain and discussed in this section.

The goal of the RIS Tool is to check the adherence of each girder bridges' activities with the recommended Maintenance, Preservation, and Rehabilitation activities that are prescribed in the RIS document. Because the Activity Log is built in Microsoft Access and original data entry is not required for the RIS tool, we moved the visual basic programming from Excel into Access. Based on feedback from the TAG during the April 2020 meeting, the tool will run separately from any existing NHDOT tools/databases. The tool will accept inputs from other databases, mainly the Activity Log. The tool's main capability is to search for new activities, match them to RIS recommended activities for each girder bridge, and calculate when the activities were completed in the lifespan of each bridge. The tool will calculate the adherence, based on the activity weights determined by NHDOT experts, and show the upcoming activities on RIS timeline.

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We are building the dictionary that translates Activity Log activities to RIS activities (preliminary analysis provided below). As we complete this, we wanted to share our current understanding of the Activity Log and have several questions related to this, which are summarized in the “Items needed from NHDOT” section.

Based on our understanding of the datasets, we adopted the following meanings:

Activity: different Activity IDs refer to different bridge maintenance activities. The Activity file also connects Activity IDs to Log IDs.

Log: the Log sheet contains the Log IDs for different structure numbers or bridges with the activity date, construction by, cost of construction, project number and the inspector identification number. Some of the bridges have multiple Log IDs. Is a Log ID a unique identifier for when the data was input into the database?

Girder Only: this data sheet contains updated 3850 bridges in NH along with their Bridge ID, Structure Number, NH-BR type, Structure type and their respective tiers.

The RIS activities are matched to activity names from the NHDOT Activity Log. Based on the RIS document, most of the activities like Crack Seal Pavement, Pavement Inlay repeat after 10 to 20 years, so, the unique activities are highlighted in blue. Here, some Log IDs are provided just to give an example, but there are more than one Log ID for each NHDOT Log Maintenance Activity. This was discussed at the August TAG meeting and it was suggested that a small group review with the project sponsor would be best to move this activity forward.

RIS activities for Girder Bridges	Maintenance activities on the NHDOT Log Files	Year Freq.	Category of Work	Responsible Bureau	Example Log ID
Clean and Seal, Clear Debris	Clearing and Grubbing	Annually	Maintenance	Bridge Maintenance	1059 2208
Crack Seal Pavement	Strip Seal; Seal Replacement	5	Preservation	Highway Design	2037 1992
Pavement Inlay	Grind/Replace Asphalt	110	Preservation	Highway Design	2049
Crack Seal Pavement	Strip Seal; Seal Replacement	15	Preservation	Highway Design	677
Patch Deck and Substructure	Partial Patch; Full Patch	20	Preservation	Bridge Design	686 688
Replace membrane, pavement and Expansion joints	Grind/Replace Asphalt; Seal Replacement; Bearing Replacement	20	Preservation	Bridge Design	772 753 820
Rehab Bearings	550.201 All Bearings; Bearing Repair; Repair Pier Caps and Replace Bearings	20	Preservation	Bridge Design	3731 1088 2298
Touch Up Paint (If Applicable)	Paint	20	Preservation	Bridge Design	1095
Crack Seal Pavement	Strip Seal; Seal Replacement	25	Preservation	Highway Design	2037 1992
Pavement Inlay	Asphalt all courses	30	Preservation	Highway Design	662
Crack Seal Pavement	Strip Seal; Seal Replacement	35	Preservation	Highway Design	2037 1992
Patch Deck and Substructure	Partial Patch; Full Patch	40	Preservation	Bridge Design	686 688

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Replace membrane, pavement and Expansion joints	Grind/Replace Asphalt; Seal Replacement; Bearing Replacement	40	Preservation	Bridge Design	772 753 820
Rehab Bearings	550.201 All Bearings; Bearing Repair; Repair Pier Caps and Replace Bearings	40	Preservation	Bridge Design	3731 1088 2298
Touch Up Paint (If Applicable)	Paint	40	Preservation	Bridge Design	1095
Crack Seal Pavement	Strip Seal; Seal Replacement	45	Preservation	Highway Design	2037 1992
Pavement Inlay	Grind/Replace Asphalt	50	Preservation	Highway Design	2049
Crack Seal Pavement	Strip Seal; Seal Replacement	55	Preservation	Highway Design	2037 1992
Replace Deck, Membrane, Pavement and Joints	Grind/replace asphalt; Bearing Replacement; Seal Replacement;	60	Rehabilitation	Bridge Design	2049 2087 1992
Replace Bearings	Bearing Replacement	60	Rehabilitation	Bridge Design	2085
Patch Substructure	Abutments and wings patched as needed	60	Rehabilitation	Bridge Design	4004
New Paint (If Applicable)	Paint	60	Rehabilitation	Bridge Design	1905
Crack Seal Pavement	Strip Seal; Seal Replacement	65	Preservation	Highway Design	2037 1992
Pavement Inlay	Grind/Replace Asphalt	70	Preservation	Highway Design	2049
Crack Seal Pavement	Strip Seal; Seal Replacement	75	Preservation	Highway Design	2037 1992
Patch Deck and Substructure	Partial Patch; Full Patch	80	Preservation	Bridge Design	686 688
Replace membrane, pavement and Expansion joints	Grind/Replace Asphalt; Seal Replacement; Bearing Replacement	80	Preservation	Bridge Design	772 753 820
Rehab Bearings	550.201 All Bearings; Bearing Repair; Repair Pier Caps and Replace Bearings	80	Preservation	Bridge Design	3731 1088 2298
Touch Up Paint (If Applicable)	Paint	80	Preservation	Bridge Design	1095
Crack Seal Pavement	Strip Seal; Seal Replacement	85	Preservation	Highway Design	2037 1992
Pavement Inlay	Grind/Replace Asphalt	90	Preservation	Highway Design	2049
Crack Seal Pavement	Strip Seal; Seal Replacement	95	Preservation	Highway Design	2037 1992
Patch Deck and Substructure	Partial Patch; Full Patch	100	Preservation	Bridge Design	686 688

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Replace membrane, pavement and Expansion joints	Grind/Replace Asphalt; Seal Replacement; Bearing Replacement	100	Preservation	Bridge Design	772 753 820
Rehab Bearings	550.201 All Bearings; Bearing Repair; Repair Pier Caps and Replace Bearings	100	Preservation	Bridge Design	3731 1088 2298
Touch Up Paint (If Applicable)	Paint	100	Preservation	Bridge Design	1095
Crack Seal Pavement	Strip Seal; Seal Replacement	105	Preservation	Highway Design	2037 1992
Pavement Inlay	Grind/Replace Asphalt	110	Preservation	Highway Design	2049
Crack Seal Pavement	Strip Seal; Seal Replacement	115	Preservation	Highway Design	2037 1992
Replace Bridge (or superstructure)	Replacement; Superstructure Replacement	120	Replacement	Bridge Design	140 123

A few notes/questions about the Activity Log data:

- Some of the activity names (e.g. Clearing and Grubbing, Grind/Replace Asphalt) do not match directly with the activity names described in the RIS document. For example, Crack Seal Pavement in the RIS document does not match exactly with any of the activity names of the NHDOT bridge log. We have defined some of the activities and connected with the RIS activities and will provide that under separate cover for review.
- Multiple Activity IDs and Log IDs are present for the same activity names. For example, an activity “Grind/Replace Asphalt” has Activity ID of 76 and Log ID of 24, as well as Activity ID of 145 and Log ID of 40.

Items needed from NHDOT

- Questions for the DOT
 - Is a Log ID a unique identifier for when the data was input into the database?
 - Does the DOT have specific definitions for activities?
 - Is the current connection between Activity Log activities and RIS activities acceptable?
- We propose a small-group Zoom meeting, prior to the next TAG meeting, to discuss the following items:
 - Walk-through of Activity Log database (answer questions presented in above RIS Tool section)
 - Inventory of available data for bridge activity and condition tracking
 - Participant list for expert solicitation
 - Continued COVID-19 limitations, particularly the inability to perform in-person research at the DOT

Anticipated research next three(3) months:

In the next three months, focus on the adherence measure for the NHDOT-RIS and tool development to address needs of NHDOT. The literature review will be shared with the project sponsor and shared for feedback.

After coordinating with the project sponsor and receiving further input on our questions, we will select a sample set of bridges for final approval by NHDOT for adherence measure evaluation.

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The expert solicitation plan is under review by UNH IRB. The survey questions will be shared with the TAG – attached to this report – for discussion at a dedicated ZOOM meeting prior to the survey distribution.

The UNH team would like to schedule a small-group Zoom meeting in October prior to the next TAG meeting. This will include a discussion of potential scope modifications based on continued COVID-19 disruptions (see below for more detail).

Circumstances affecting project:

The COVID-19 pandemic has caused major disruptions to UNH and the broader community. Currently, faculty and students are in a hybrid semester, which includes a combination of remote work and restricted on-campus activity. Human subjects research is generally not allowed, particularly in cases where indoor face-to-face work is required, which is the case for this project. While most elements of this project will be able to continue, Task 3 from the project work plan requires visits to NHDOT offices and in-person coordination, so at this time Task 3 is on hold. The DOT project sponsor and UNH PI have had initial discussion about the potential to revise the project scope based on the COVID-19 restrictions. For example, there would no longer be any in-person data collection at the DOT and the adherence tool may be simplified based on these data limitations. Discussions are still ongoing and any proposed modifications to the scope will be shared with the TAG as soon as possible.

Tasks (from Work Plan)	Planned % Complete	Actual % Complete
Task 1: Assessment of published data mining and analysis to select the appropriate scheme for NHDOT based on inventory and investment records. This assessment will include an evaluation of data availability and actions needed to improve availability, if appropriate.	100	75
Task 2: Development of a framework to measure adherence to RIS.	75	75
Task 3: Data mining and preparation of element-level Bridge condition assessment data and maintenance records.	25	0
Task 4: Development of network level deterioration functions for bridge elements	25	25
Task 5: Proof-of-concept deterioration forecasts using sample adherences for New Hampshire bridges for girder type bridges, including network-wide and region/corridor specific zones.	0	0
Task 6: Report Research Results and Deliver Final Products	0	0